Gray Whales: Could Climate Change Risk Their Recovery?

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Outline

- Gray Whale Biology
- Population Status
- Sentinels of Climate Change (CC)
  - Cyclical CC
  - Directional CC
  - Impacts on grays
- My research
- Conclusions
Gray Whale Basics

*Eschrichtius robustus*

- **Mysticete**: Baleen
- **Coloration**: Gray
- **Size**: 36 - 50’
- **Weight**: 30 - 45 tons
- **Maturity**: 5 - 11 yrs
- **Lifespan**: 40 - 50 yrs
Historical Distribution

Red – extinct

Green – extant populations
Extant Populations

Western Northern Pacific – critically endangered
- summer - Okhotsk Sea (Russia), winter location? – China Sea?

Eastern Northern Pacific – “recovered”
- summer in Arctic, winter in Baja
ENP Migratory Path

- Breed in Baja: Jan - April
  - Fast (?)

- Migrate North in spring
  - staggered by age & sex

- Feed in Bering/Chukchi Seas: June - Oct
  - some feed further south

- Migrate South in fall

- Migrate 18,000 km rt annually
Reproduction

- Mating System
  - Sperm competition
  - Dance? New

- Gestation
  - 14 months
  - 15’ at birth

- Lactation
  - 8 months
  - 50% fat
Feeding & Diet

Benthic prey - amphipods & ghost shrimp

Pelagic prey - mysids, amphipods, crab larvae
Recovery

1994 - Removed from Endangered Species List

- Census counts match pre-whaling estimates
- BUT Genetic diversity estimates population <50% of historical abundance (Alter et al. 2007)
Threats

Makahs in Washington
- renew 1855 treaty rights to hunt grays

Orcas (Killer Whales)
- main predator
- target calves; up to 30% mortality

Climate Change
Ocean Acidification?
Population Status

- Decline in ’99-’00
  - High mortality
  - Low calf production

- Did they hit K? (LeBoeuf et al. 2000)

- Disease or Toxins? (Moore et al. 2001)

- ENSO?
Ecosystem Sentinels

“Marine mammals integrate and reflect ecological variation across large spatial and temporal scales” (Moore 2008)

- Most studies use chlorophyll a to describe ocean productivity and relate to abiotic conditions
- Rarely include predators
- Polar cetaceans reflect rapid changes while migratory mysticetes are useful for broadscale shifts
- Evidence grays responding to ecosystem changes, so ideal sentinels
Ocean Acidification

• Effects on marine mammals have not been studied yet, but there is concern

“The potential impacts of ocean acidification on cetaceans merit future in-depth consideration…and may have implications for the management of whale populations.”

(Bates et al.)
Cyclical Climate Change

Pacific Decadal Oscillation (PDO)

- long-term cycling sea surface temp (SST)
- “regime shift” in late ’70’s
- correlates w/ productivity & declining marine mammals

Arctic Oscillation (AO)

- alternating pressure
- positive phase – low pressure in Arctic, decline zooplankton & salmon
Evidence: Migratory Timing

- Delay (1 week later) in southbound migration after 1980 (Rugh et al. 2001)
  - Coincides with North Pacific “regime shift” (PDO)

Why?
- Starting from further north so takes longer to migrate
- Decline in prey, need more feeding time to store reserves?
Calves Born During Migration

- Increase in # of Calves born during S. bound migration (Shelden et al. 2004)
  - With 1 week delay, births should occur 1000 km N
  - Warmer water may help calves survive outside of lagoons
Cyclical Climate Change: El Nino-Southern Oscillation (ENSO)

**Normal year:**
- Trade winds cause upwelling of nutrients
- High productivity

**ENSO year:**
- Weak trade winds, no upwelling
- High SST
- Low productivity
El Nino (ENSO) 97-98
Evidence: Trends in Lagoons

  - El Nino - distribution shifted North; La Nina - shifted South and into Gulf of CA
  - Cow-calf pairs: decline #s, delay in peak occupancy
  - Normally 1/3 of pairs use areas outside of lagoons, but >50% in 1998
  - Longer calving interval measured ’96-00 vs ’77-82: density dependent response b/c pop near K or related to ENSO?
Directional Climate Change: Global Warming

- Ocean Warming
- Rise in Sea Level
Evidence: Chirikov Basin

- “Hole” in Chirikov Basin; grays still feeding in traditional area North (Moore et al. 2003)
Evidence: Chirikov Basin

- Concurrent decline in amphipods because:
  - Reduced carbon & nutrient transfer linked to PDO
  - Coarser sediments, problem for tube-dwelling amphipods
  - Warmer water slows amphipod growth, reduces brood size & lifespan (Highsmith & Coyle, 1991)
  - Competition between invertebrates
  - Gray whale over-predation

- Carrying capacity of Bering-Chukchi ecosystem declined by 30% in last 30 yrs (Springer 2000)
Global Warming (cont.)

- Loss of sea ice

- Coastal algal blooms
Ice Impacts

- Arctic productivity is light-limited
  - Chukchi sea has become cloudier since 1984 (Bond 2008)
  - Ice Cover advances during El Nino
  - 8% decrease/decade since 1970’s (Fiedler 2008)
  - 2007 max open water area, increased primary productivity (Fiedler 2008)
  - But potential negatives: freshwater inflow and increased risk of predation
Evidence: Calf Production

- Fluctuating # of calves migrating North (Perryman et al. 2002)
  - Highest calf counts associated with length of time the Chirikov Basin was ice-free
  - Ice blocks access to feeding grounds
  - Correlation only during pregnancy not ovulation
  - Major anomalies in ice coverage in early ’80’s but no effect on calves

What changed?
Evidence: Year-round Whales

- Grays observed feeding year-round in Alaska (Moore et al. 2007)
  - Commonly feeding in former migratory areas
  - Feeding on cumaceans, atypical prey, and amphipods absent

- Calls detected on autonomous recorders in W. Beaufort sea in winter (Stafford et al. 2007)
  - Cracks in sea ice observed on satellite images, allowed them to breathe
Skinny Whales

- 10% of grays in Baja emaciated in 2007

Decline in prey biomass (Coyle et al. 2007) due to:
- over-consumption by grays?
- ecosystem shift? (Grebmeier et al. 2006)
- climate change?
Southern Feeding Grounds

- Seasonal residents from S. Alaska to N. CA
- Population ~200-250, stable since 1998 (Calambokidis 2008)
- Cyclic abundance of grays in BC, appears linked to prey crashes (Feyrer et al 2008, Maud et al 2008)
My Current Research

- Photo-ID in BC, CA, Baja
Current Research: Migratory Physiology

Shore-based observations:
• Swim speeds & respiration rates

GIS maps
• integrate oceanography, prey and whale data
Future: Prey

- ROV in situ observations

- Rear prey in aquaria to study effects of:
  - pH
  - temperature
  - nutrients
Conclusions

- Gray whales are Sentinels of Climate Change
- Impact of Ocean Acidification?
  - likely indirect effects via changes in prey’s prey
Want to contribute to the gray whale research?
Join our Earthwatch expeditions!

“Whales of British Columbia”
1-2 week trips July – Sept

“Discovery Weekends in Palos Verdes”
Jan-April

or

Send photos & GPS data
References

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- Bond “North Pacific – Arctic ocean climate oscillations
- Calambokidis et al. “Seasonal resident gray whales in the Pacific Northwest: results from collaborative research between 1999 to 2007”
- Fiedler “ENSO and longer-term variability of productivity in the North Pacific”
- Feyrer et al. “The beggar’s banquet: gray whale predator-prey dynamics on the outskirts”
- Maud et al. “Switching predator in a changing ocean: is predator-prey cycling in grey whales feeding near Cape Caution, VC, sustainable?”
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